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CALIFORNIA FOREST AND RANGE EXPERIMENT STATION

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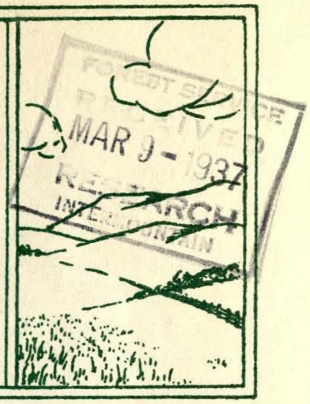

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AN INFILTRATION STUDY

OF A DENUDED AND A FOREST COVERED SOIL[1/]

One of the important functions of the forest in relation to run-off and erosion is that of developing and maintaining soil permeability. This in turn materially increases the absorption or infiltration capacity of a soil for precipitation. The extent of this influence of the forest cover is demonstrated by a series of infiltration tests made at Kennett, California, on smelter fume denuded and adjacent forested soils.

In 1905 both soils were the same. They supported a vegetation similar to that now found on the forested soil and possessed like chemical and physical properties. In that year a smelter was established and by 1910 the toxic effect of the smelter fumes had completely destroyed the forest growth on 67,000 acres and had severely damaged the vegetation on an additional 86,000 acres. Although operation of the smelter was later discontinued, vegetation has never reclaimed the area.

The Kennett soils, developed under a temperate climate with an average annual precipitation of 59.3 inches, are immature, red, rocky, gravelly clay loams formed in situ from undifferentiated metamorphosed limestones, slates, and quartzites. They normally support an open, brushy Douglas fir - ponderosa pine vegetative type of sufficient density when undisturbed to afford adequate protection against erosion and flood hazards.

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In determining differences in the infiltration capacities of the soils a modification of the Auten tube method[2] was used. This method employs a brass tube 2 inches in diameter and 12 inches long which when a test is to be made is placed into the soil to a depth of 3 centimeters. It is then filled with water which is held at a constant head during the run. The volume of water required to maintain the water level is measured as it is added to the tube and recorded at 5-minute intervals. A comparison of the rates at which water is absorbed yields an empirical measure of the infiltration capacity of the soils sampled.

Fifteen infiltration tests were made at Kennett, 8 on the denuded soil and 7 on the adjacent forested areas. The duration of the individual runs averaged approximately 20 minutes, totaling 295 minutes. The small number of runs and the rocky texture of the soil resulted in a high experimental error. However, analysis of the data shows the differences in the infiltration rates of the forested and denuded areas to be so great as to be highly significant.[3] That is, were other tests to be made similar differences would be expected in more than 99 percent of the trials.

Results of the tests show that the quantity of water entering both covered and denuded soils decreased rapidly during the first 15 minutes of infiltration, becoming more or less constant during the following 10 minutes. The rapid absorption at the start of the runs was largely due to the original dryness of the soil and to disturbances in placing the tube. Although the forested soil appeared to be the slower in reaching a constant infiltration rate the soils sampled were not significantly different in this respect.

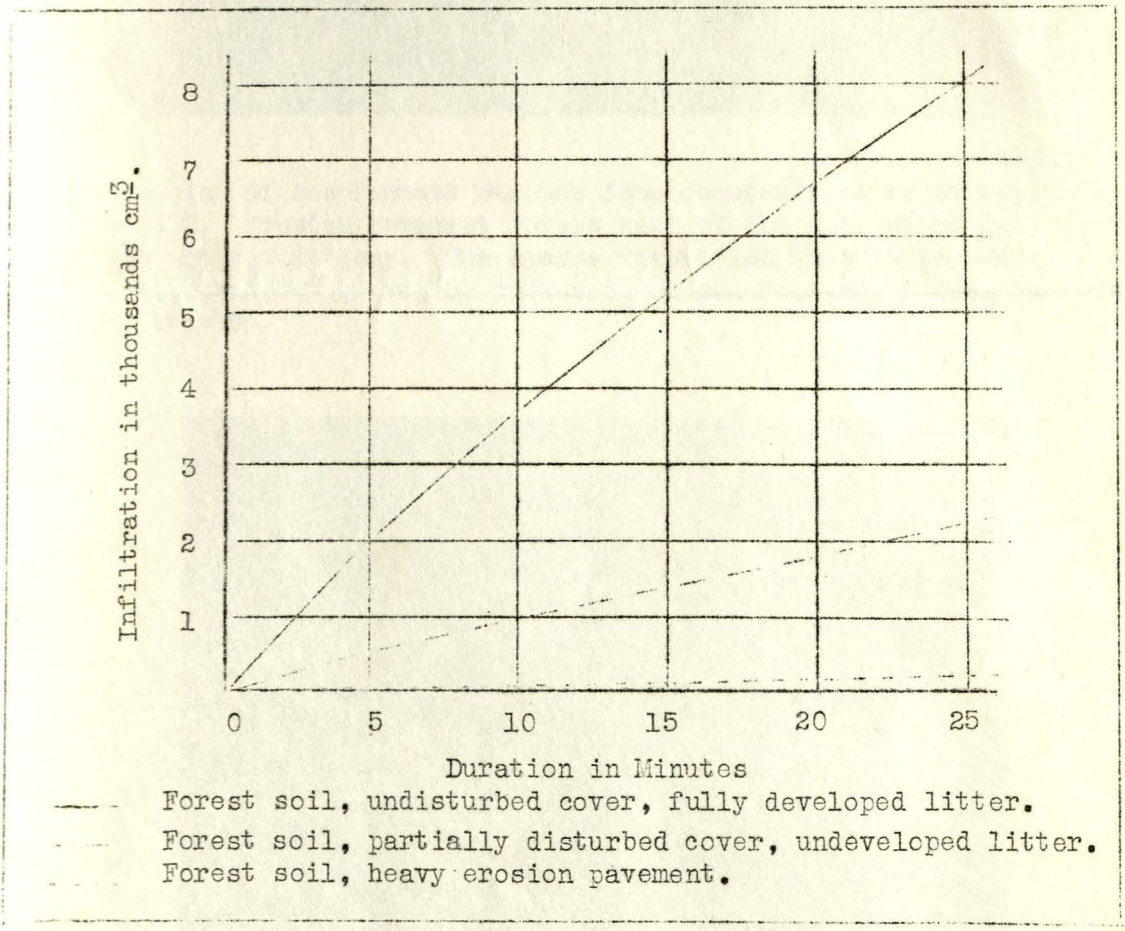
Average infiltration rates presented quite a different story, varying greatly with differences in the surface conditions of the soil sampled. Infiltration was slowest on denuded soil having a heavy erosion pavement with its almost impervious top layer. Where surface run-off had occurred at intensities sufficient to remove the erosion pavement, the infiltration capacity of the soil was slightly increased. The lowest infiltration rate recorded for the forested soil was more than double the highest rate on the denuded soil. The lowest rate on forested soil was for those portions that had been partially affected by smelter fumes; the highest occurred under the less disturbed stands with a fully developed litter cover.

2/ Auten, J. T. June 1933. Porosity and water absorption of forest soils. Journal of Agricultural Research 46:11, 997-1014.

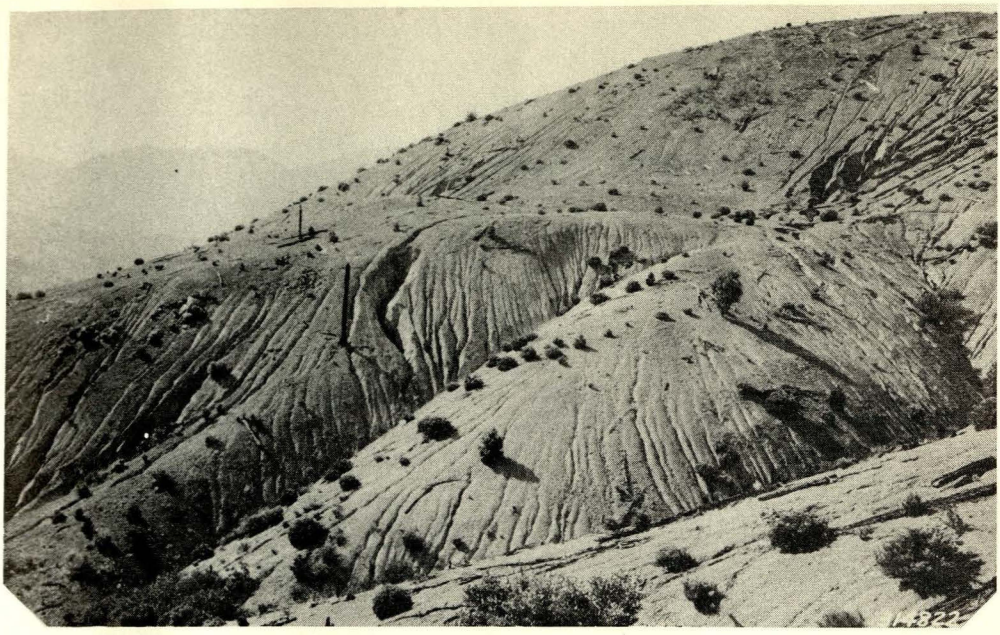
3/ Snedecor, George W. 1934. Calculation and interpretation of analysis of variance and covariance. Ames, Iowa: Collegiate Press, Inc.

Numerically, the infiltration for the denuded soils tested was at an average rate of 23.5 cm^3 per minute with a range of 9.8 to 41.2 cm^3. For forested soils the infiltration ranged from 90.4 to 321.0 cm^3 per minute, averaging 263.7 cm^3. Thus the forested soil absorbed 2.2 to 32.8 times or an average of 13.2 times as much water in a given interval as did the denuded soil.

Inasmuch as these two soils were the same some twenty-six years ago it may be concluded (1) that the vast differences in their present infiltration capacities are largely due to the influence of forest cover; (2) that the destruction of the forest has impaired the ability of the denuded soil to absorb precipitation, resulting in accelerated surface run-off and erosion and finally complete devastation of the area.



Typical infiltration runs showing the influence of vegetation in maintaining the soil permeability.



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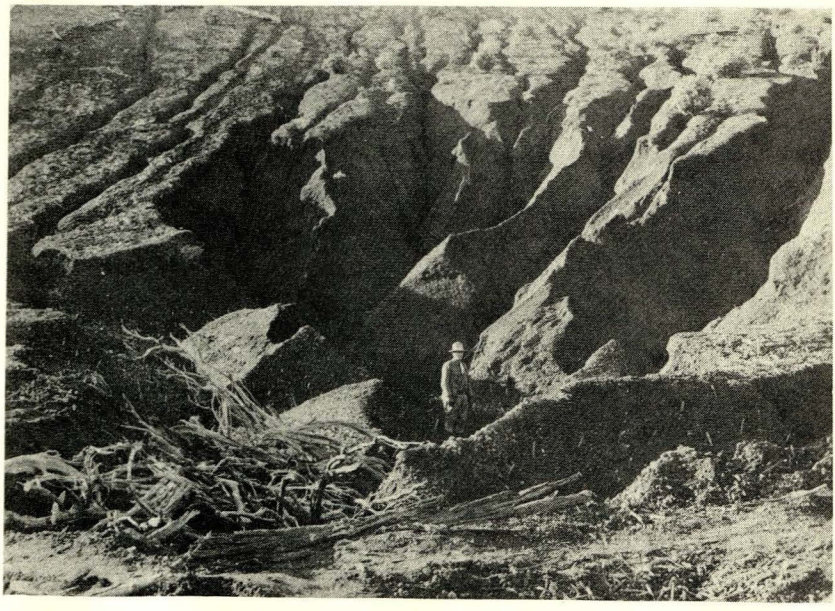
A portion of the Kennett smelter fume denuded area as it appeared in 1935. Erosion pavement covers most of the soil where gullies have not cut it away. The sparse vegetation that is becoming established has as yet no influence in controlling surface run-off and erosion.



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This close-up of the gullies appearing in the upper right hand corner of the first photograph gives an idea of the quantity of material removed in the 25 years since the area was denuded.